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GB 2164762 A
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(54) Abstract Title: **Retroreflective device for use in retroreflective surfaces**

(57) The retroreflective device 1, primarily for use road markings, road coatings etc, comprises an agglomeration of glass beads 2, with the beads preferably being chosen due to their size and refractive index in accordance with the desired reflectivity of the finished device. The glass beads may be bound together by an adhesive material 3, such as epoxy resin, acrylic, polyurethane or a hot metal adhesive, which may be pigmented so as to colour the light reflected from the device. The agglomeration of glass beads may be approximately spherical or ovoid. Also claimed is a method of manufacturing the devices which comprises the steps of forming a bed of glass beads of a selected size and then introducing droplets of a binder material into the bed so that groups of beads bind together.

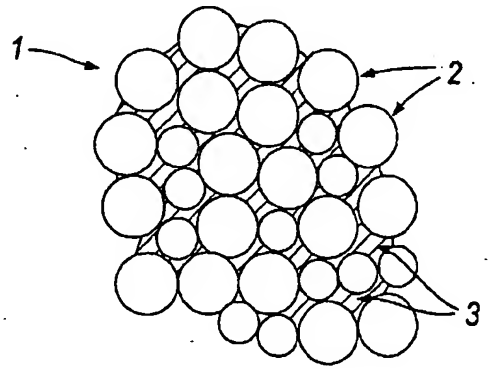

Fig.1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

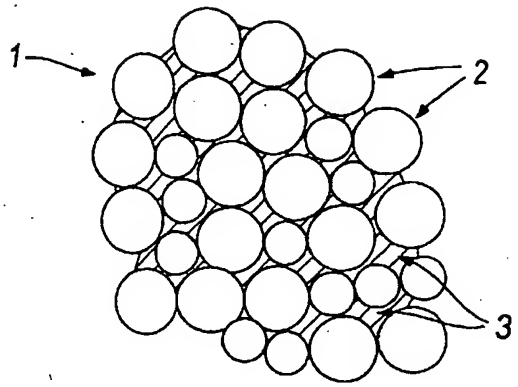

Fig.1

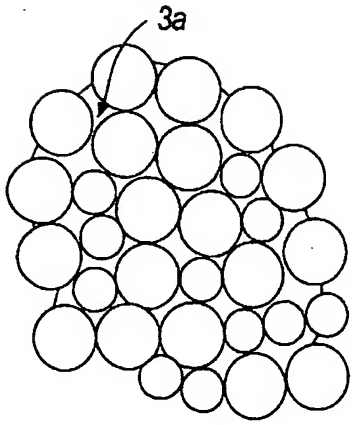

Fig.2A

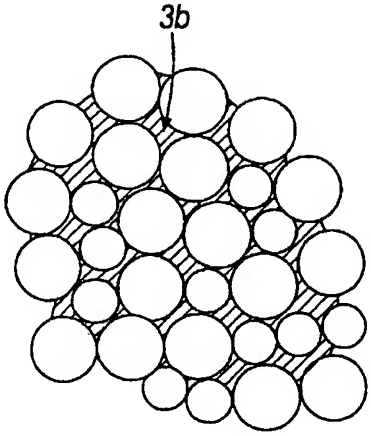

Fig.2B

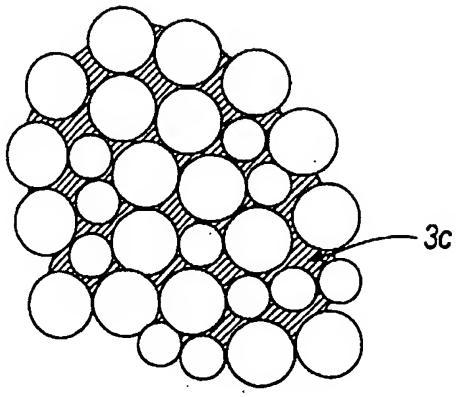

Fig.2C

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RETROREFLECTIVE DEVICE AND METHOD OF MANUFACTURE THEREOF

The present invention relates to a retroreflective device for use in creating retroreflective surfaces, for example for use as reflective markings and delineators, and high visibility coatings for improving visibility of surfaces by increasing reflective characteristics, particularly but not exclusively on roads and road signs, and a method of manufacturing such a retroreflective device.

Markings for highway (road) marking are usually required to be reflective at night. Light emitted from vehicle headlights is reflected back in the direction of the source, i.e. retroreflected, from the surface of the marking or other reflective surface. The retroreflective characteristic of the marking material is typically improved by use of added retroreflective elements or devices. In road markings, spherical glass beads are often added to the surface of the marking during application, or sometimes premixed in the body of the marking material, and by this means the retroreflective characteristics are significantly improved over the natural reflective property of the marking surface. However, road markings are usually applied in locations likely to be exposed to traffic, i.e. contacted by vehicle wheels, and such contact leads to deterioration, through abrasion and other effects, of the reflective material, thereby reducing its retroreflective properties.

Accordingly, it is desirable to provide a retroreflective device which, when used in combination with a road marking paint or coating, will impart very

good reflectivity characteristics and be durable under the action of traffic.

According to an embodiment of a first aspect of the present invention there is provided a retroreflective device for use in creating a retroreflective surface, which device comprises an agglomeration of glass beads.

Preferably, the agglomeration is formed by binding together glass beads of a selected size.

Advantageously, selected properties of each glass bead may be chosen in accordance with the desired retroreflectivity of the device, for example its refractive index.

Desirably, the glass beads are bound together by an adhesive material, for example epoxy resin, acrylic, polyurethane or a hot melt adhesive, or any other suitable adhesive.

The adhesive material may be pigmented, thereby to colour retroreflected light from the device.

The agglomeration of glass beads is desirably approximately spherical or ovoid and the glass beads are preferably approximately spherical. The diameter of the glass beads is preferably selected to be within one of the following ranges: from 100 microns to 300 microns, from 200 microns to 400 microns, or from 400 microns to 700 microns. Larger beads may be used to form agglomerations, but the ranges specified are preferred sizes for the application.

The glass beads are preferably spherical and formed of good quality clear glass substantially free from faults and inclusions. They preferably exhibit a refractive index of 1.5, 1.9 or 2.1.

Retroreflective devices embodying the present invention can advantageously be used to enhance the reflectivity of road surfacing materials and road markings, including coloured road surfacing, traffic calming, etc.

The use of a pigmented adhesive or binder allows for coloured reflection of light depending on the type and properties of the pigment and binder/adhesive used. Retroreflective devices embodying the present invention, and which comprise pigmented adhesive or binder, have been found to exhibit far superior reflectance of colour when compared to known products. This beneficial property is due to a number of factors including: the use of glass beads of a specific quality/refractive index and of a predetermined uniform size, and the closely packed construction of the device, i.e. the glass beads are bound together in very close proximity. In addition to close packing of glass beads throughout the body of the retroreflective device, the glass beads on the surface of the bead cluster are also close packed thereby achieving optimum reflective performance and resistance to traffic and/or weathering. A retroreflective device embodying the present invention will therefore have a high density of glass spheres on the surface which are in contact with a large surface area of colour thereby maximising the extent to which the colour of incident light will be modified by the device. This achieves far superior colour density and intensity of reflected light and is demonstrably better than known products comprising ordinary glass beads of various sizes simply embedded or partially embedded in a coloured binder.

According to an embodiment of a second aspect of the present invention there is provided use of a plurality of retroreflective devices embodying the first aspect of the present invention in combination with road marking material as a retroreflective road marking coating or road surfacing material.

According to an embodiment of a third aspect of the present invention there is provided use of a plurality of retroreflective devices embodying the first aspect of the present invention in combination with a binder material as a retroreflective surface dressing.

According to an embodiment of a fourth aspect of the present invention there is provided a retroreflective road marking coating comprising a road marking material applied to the surface of a road and a plurality of retroreflective devices embodying the first aspect of the present invention embedded in the road marking material so as to protrude partially therefrom. The retroreflective devices may be premixed or otherwise immersed in the road marking material.

According to an embodiment of a fifth aspect of the present invention there is provided a retroreflective surface dressing comprising a binder material coating the surface to be dressed and a plurality of retroreflective devices embodying the first aspect of the present invention adhering to the binder material so as to protrude partially therefrom.

According to an embodiment of a sixth aspect of the present invention there is provided a method of manufacturing a retroreflective device, which method comprises the steps of: (a) forming a bed of glass beads of a selected size; and (b) introducing droplets

of a binder material into the bed of glass beads so as to cause groups of the glass beads to bind together as the binder material hardens, or is cured, to form respective retroreflective devices, the size of the droplets being controlled in dependence upon the size of the glass beads so as to obtain a plurality of retroreflective devices in a preselected size range.

The binder material may be sprayed, with suitable droplet size, onto the bed of glass beads.

Preferably, the bed of glass beads is moved from a first position at which the binder material is introduced to a second position at which, after the binder material has set/cured, the retroreflective devices are removed from the bed and any loose beads are returned to the first position.

Reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows a retroreflective device embodying the first aspect of the present invention; and

Figures 2A, 2B and 2C show respective alternative embodiments of the first aspect of the present invention.

As shown in Figure 1, a retroreflective device 1 embodying the present invention is manufactured by binding a quantity of spherical glass beads 2 of a desired size with an adhesive 3 so as to form a spherical or ovoid agglomeration or cluster 1, preferably 2 to 4 mm in diameter (although other sizes may be useful according to the application). The size of the glass beads 2 is preferably selected to be within one of the following ranges, from 100 microns to 300 microns, from 200 microns to 400 microns, or from 400 microns to 700 microns, although larger beads may

also be used to form agglomerations where appropriate. The adhesive 3 may, for example, be epoxy resin, acrylic, polyurethane or hot melt adhesive. The cluster 1 of beads 2 so formed has retroreflective properties as its surface is made up of a number of glass spheres in close packed formation presenting a large number of reflecting elements. Light entering a bead 2 is reflected internally and re-emitted in the direction of the source. The light returning to the source (e.g. the vehicle) can be modified in colour by using a pigmented adhesive 3a, 3b or 3c to bind the beads 2, as shown in Figs. 2A to 2C. The pigmented adhesive 3a, 3b, 3c forms a coloured backing to the glass beads 2. Light entering the glass beads 2 is subject to internal reflection and allows some diffusion into the pigmented adhesive 3a, 3b, 3c. By this means the light colour is modified by the effect of the pigmented adhesive 3a, 3b, 3c and is thus modified before it returns in the direction of the source. The adhesive material 3 may be pigmented with white, red, yellow, green, or indeed any strong colour, to produce a reflected colour as required. Alternatively, the glass may itself be coloured to modify the light, either by the chemical composition of the glass or by a suitable coating treatment. By this means the bead clusters 1 may be used in road markings and other road surfacing to produce a coloured appearance as an aid to driver safety and to provide information about road layout and possible hazardous situations.

The properties of the glass used to make the beads 2, such as its chemical formulation, may be varied to achieve a greater degree of reflectivity. In

particular, glass of different refractive index, for example values of 1.5, 1.9 and 2.1, may be used, since glass beads 2 manufactured from higher refractive index glasses return more light and therefore improve the retroreflective performance. Additionally, a mixture of glass beads of different refractive indices may be used.

In order to obtain a retroreflective surface, a plurality of retroreflective devices 1 embodying the present invention are applied to the still liquid or semi-liquid surface of a road marking material painted onto a road and become embedded in the surface so that they are anchored in the surface with a portion of each retroreflective device 1 protruding above the surface of the marking, such that the exposed part of the bead clusters 1 can become illuminated with light from head lamps of vehicles and reflect light back to the driver. The bead clusters 1 embedded into the surface are firmly held by the road marking material, the surface structure of each cluster 1 being textured by the presence of glass beads 2 so that the road marking material is absorbed into the textured surface of the cluster 1, this keying effect increasing retention and strength of adhesion of the bead cluster 1.

As mentioned above, the size of the cluster 1 is usefully in the range from 2mm to 4mm diameter; however, larger or smaller clusters 1 may be used in accordance with the thickness of the coating for which they are intended and the degree of embedment. Thus a road marking paint line nominally 500 microns in thickness could use clusters 1 in the size range 1mm to 2mm diameter, whereas a thicker line such as a thermoplastic road marking nominally 3mm in depth would

require clusters 1 of 4mm to 6mm diameter to be effective.

An alternative use of the retroreflective devices 1 would be in a road surface dressing, coloured road surfaces for hazard warning, or on vertical surfaces, for example safety barriers, road signs (vertical), etc. These applications would require a relatively low thickness of binder material to allow a large exposed area of reflective material. Such usage requires a particularly strong and durable binder to hold the clusters 1 to the substrate, for example (but not exclusively) two component materials epoxy resin, acrylic and polyurethane.

Unlike prior art road markings whose reflectivity is provided by individual glass beads and which therefore lose reflectivity as the beads become damaged or are dislodged from the surface due to the action of traffic, retroreflective devices 1 embodying the present invention comprise an agglomeration of glass beads 2 having a multilayer structure which enables continuity of reflectivity by exposing a new, inner layer of glass beads 2 after the original outer layer of beads 2 has been removed, for example by the action of road traffic.

Rather than being applied on a surface, the retroreflective devices 1 can also be advantageously used as premixed additives to a road marking material, in a quantity proportional to the thickness of the coating to be applied, the devices becoming exposed as the road marking material wears away.

In a method of manufacturing a retroreflective device 1 embodying the present invention a small droplet of adhesive or binder material 3 is applied to

a mass or bed of glass beads 2 and the binder material 3 is absorbed onto the surface of the beads 2 immediately surrounding the droplet. The binder material 3 is then cured and the resultant agglomeration or cluster 1 of glass beads 2 is separated from the uncoated beads 2. The size of the binder droplet, physical properties of the binder material 3 (particularly its viscosity and cure rate) and the size/gradation of the glass beads 2 are key factors which determine the quality of the agglomeration of beads produced. Two examples of production methods are given below:

Method 1

A flat bed of glass beads 2 is produced and onto the surface is applied individual droplets of the binder material 3 using a suitable device 1 for generating controlled size of droplets. The droplet size and gradation of glass beads 2 will determine the size of bead clusters 1 produced, the agglomeration of beads 2 increasing in size if there is more binder 3 available. As the binder 3 flows from its point of application it will contact further layers of glass beads 2 and increase the size of cluster 1 formed. An example of a workable system is a glass bead size of nominal diameter 200 microns with a droplet size of 2mm; this will agglomerate a quantity of beads 2 to produce a cluster 1 of size 3mm to 4mm diameter. The flat bed can be produced as a moving bed of beads 2, for example on a moving belt, with binder 3 applied dropwise with a collection device 1 at a suitable distance to separate clusters 1 from loose beads 2, the loose beads 2 being recycled back into the moving belt to enable a continuous process. The time between

application of the binder 3 and the collection and separation process needs to be controlled to enable setting/curing of the binder 3 to a sufficient degree to allow handling of the product without damage or disruption to the agglomeration of beads 2. The process of binder cure can be speeded up by, for example, the application of heat, allowing faster processing of the beads 2.

Method 2

An alternative to the drop application method is to spray the binder 3 on to the surface of a moving bed of glass beads 2. This may be advantageous in terms of droplet size, particularly if smaller diameters of droplet are required, for example less than 1000μm in diameter. It may also be advantageous in allowing faster production rates. Various spray devices may be used, for example air assisted atomisation, spinning disc (prilling), etc.

Thus, retroreflective devices 1 embodying the present invention have a retroreflectivity performance providing efficient retroreflection of incident light. When used in road marking or surfacing materials to increase visibility in low light or night-time conditions the devices have higher durability under traffic than the individual glass beads 2 used in the prior art, owing to the multi-layering of glass beads 2 in the cluster 1 and the keying effect of the surface characteristics of the cluster 1. Larger bead clusters 1 are likely to give extra visibility performance in so-called "wet night conditions", because the clusters 1 stand proud of the road marking line and are more visible when there is water on the road.

CLAIMS

1. Retroreflective device for use in creating a retroreflective surface, which device comprises an agglomeration of glass beads.

2. A device as claimed in claim 1, wherein the agglomeration is formed by binding together glass beads of a selected size.

3. A device as claimed in claim 1 or 2, wherein selected properties of each glass bead are chosen in accordance with the desired retroreflectivity of the device.

4. A device as claimed in claim 3, wherein one of the selected properties is refractive index.

5. A device as claimed in claim 2, 3 or 4, wherein the glass beads are bound together by an adhesive material.

6. A device as claimed in claim 5, wherein the adhesive material is epoxy resin, acrylic, polyurethane or a hot melt adhesive.

7. A device as claimed in claim 5 or 6, wherein the adhesive material is pigmented, thereby to colour light retroreflected from the device.

8. A device as claimed in any preceding claim, wherein the agglomeration of glass beads is approximately spherical or ovoid.

9. A device as claimed in any preceding claim, wherein the glass beads are approximately spherical.

10. A device as claimed in any preceding claim, wherein the diameter of the glass beads is selected to be within one of the following ranges: from 100 microns to 300 microns, from 200 microns to 400 microns, or from 400 microns to 700 microns.

11. Use of a plurality of retroreflective devices as claimed in any preceding claim in combination with road marking material as a retroreflective road marking coating or road surfacing material.

12. Use of a plurality of retroreflective devices as claimed in any one of claims 1 to 10 in combination with a binder material as a retroreflective surface dressing.

13. A retroreflective road marking coating comprising a road marking material applied to the surface of a road and a plurality of retroreflective devices as claimed in any one of claims 1 to 10 embedded in the road marking material so as to protrude partially therefrom.

14. A coating as claimed in claim 13, wherein the said retroreflective devices are premixed or otherwise immersed in the road marking material.

15. A retroreflective surface dressing comprising a binder material coating the surface to be dressed and a plurality of retroreflective devices as claimed in any

one of claims 1 to 10 adhering to the binder material so as to protrude partially therefrom.

16. A method of manufacturing a retroreflective device as claimed in any one of claims 1 to 10, which method comprises the steps of:

(a) forming a bed of glass beads of a selected size; and

(b) introducing droplets of a binder material into the bed of glass beads so as to cause groups of the glass beads to bind together as the binder material hardens, or is cured, to form respective retroreflective devices, the size of the droplets being controlled in dependence upon the size of the glass beads so as to obtain a plurality of retroreflective devices in a preselected size range.

17. A method as claimed in claim 16, wherein the binder material is sprayed onto the bed of glass beads.

18. A method as claimed in claim 16 or 17, wherein the bed of glass beads is moved from a first position at which the binder material is introduced to a second position at which, after the binder material has set/cured, the retroreflective devices are removed from the bed and any loose beads are returned to the first position.

INVESTOR IN PEOPLE

Application No:	GB 0313512.6	14	**Examiner:**	Charles Jarman
Claims searched:	1-18		**Date of search:**	24 July 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1-18	US 3254563	(DE VRIES ET AL) See whole document.
X	1-18	DE 19521847 A1	(ANMELDER) See whole document.
X	1-15	US 3043196	(PALMQUIST ET AL) See whole document.
X	1-7,9-15	GB 2164762 A	(POTTERS INDUSTRIES INC) See whole document
X	1-6,8-15	US 6398369 B1	(STARLING) See whole document.
X	1-5,7-15	US 5942280	(MATHERS ET AL) See whole document.
X	1-5,8-15	EP 0322671 A2	(EIGENMANN) See whole document

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

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Worldwide search of patent documents classified in the following areas of the IPC[7]:

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The following online and other databases have been used in the preparation of this search report:

WPI, PAJ, EPODOC